

|    | Type | L # | Hits | Search Text                                                                                                                                                                                                               | DBs                    |
|----|------|-----|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| 1  | IS&R | L1  | 14   | (("4154050") or ("4355646") or ("4573481") or ("4640983") or ("4677989") or ("4860446") or ("4947866") or ("5040544") or ("5324328") or ("5423881") or ("5562722") or ("6216045") or ("6343233") or ("20030032997")) .PN. | US-<br>PGPUB;<br>USPAT |
| 2  | IS&R | L2  | 5719 | ((607/2) or (607/115-117) or (607/122) or (29/825) or (29/868) or (174/102R) or (174/103) or (174/106R) or (174/102C) or (174/119R) or (174/126.1-126.2)) .CCLS.                                                          | US-<br>PGPUB;<br>USPAT |
| 3  | BRS  | L3  | 3425 | 2 and @ad<"20010628"                                                                                                                                                                                                      | US-<br>PGPUB;<br>USPAT |
| 4  | BRS  | L4  | 57   | 3 and (inner adj core)                                                                                                                                                                                                    | US-<br>PGPUB;<br>USPAT |
| 5  | BRS  | L5  | 25   | 4 and (outer adj surface)                                                                                                                                                                                                 | US-<br>PGPUB;<br>USPAT |
| 6  | BRS  | L6  | 11   | 4 and (outer adj layer)                                                                                                                                                                                                   | US-<br>PGPUB;<br>USPAT |
| 7  | BRS  | L7  | 1    | 4 and (outer adj core)                                                                                                                                                                                                    | US-<br>PGPUB;<br>USPAT |
| 8  | BRS  | L8  | 31   | 5 or 6 or 7                                                                                                                                                                                                               | US-<br>PGPUB;<br>USPAT |
| 9  | BRS  | L9  | 14   | 8 and impedance                                                                                                                                                                                                           | US-<br>PGPUB;<br>USPAT |
| 10 | BRS  | L10 | 6    | 9 and (ohms or resistance)                                                                                                                                                                                                | US-<br>PGPUB;<br>USPAT |
| 11 | BRS  | L11 | 2    | 9 and resistivity                                                                                                                                                                                                         | US-<br>PGPUB;<br>USPAT |

|    | Time Stamp          | Comments | Error Definition | Errors |
|----|---------------------|----------|------------------|--------|
| 1  | 2005/05/07<br>19:10 |          |                  |        |
| 2  | 2005/05/07<br>19:12 |          |                  |        |
| 3  | 2005/05/07<br>19:12 |          |                  |        |
| 4  | 2005/05/07<br>19:12 |          |                  |        |
| 5  | 2005/05/07<br>19:13 |          |                  |        |
| 6  | 2005/05/07<br>19:13 |          |                  |        |
| 7  | 2005/05/07<br>19:13 |          |                  |        |
| 8  | 2005/05/07<br>19:13 |          |                  |        |
| 9  | 2005/05/07<br>19:13 |          |                  |        |
| 10 | 2005/05/07<br>19:14 |          |                  |        |
| 11 | 2005/05/07<br>19:14 |          |                  |        |

|    | Type | L # | Hits | Search Text | DBs                    |
|----|------|-----|------|-------------|------------------------|
| 12 | BRS  | L12 | 6    | 10 or 11    | US-<br>PGPUB;<br>USPAT |
| 13 | BRS  | L13 | 8    | 9 not 12    | US-<br>PGPUB;<br>USPAT |

|    | Time Stamp          | Comments | Error Definition | Errors |
|----|---------------------|----------|------------------|--------|
| 12 | 2005/05/07<br>19:15 |          |                  |        |
| 13 | 2005/05/07<br>19:15 |          |                  |        |

**DETAILED ACTION**

1. Acknowledgment is made of applicant's amendment and 3-month extension of time, which were received by the Office on March 21, 2005.
2. Claims 1-16 and 21 are canceled. Claims 17-20 are active.

***Information Disclosure Statement***

3. Acknowledgment is made of applicant's Information Disclosure Statement (PTO-1449), which was received by the Office on September 23, 2004.

***Specification***

4. In view of the applicant's modifications to the specification, the Examiner is withdrawing the objections which were made against the specification in the last Office action.

***Claim Rejections - 35 USC § 102***

5. In view of applicant's cancellation of claims 1-16 and 21, the Examiner is withdrawing the 35 U.S.C 102(b) rejections of Lessar et al '866 and Laske et al'341, which were made against claims 1-16 and 21 in the last Office action.

***Allowable Subject Matter***

6. Claims 17-20 are allowed.

***Reasons for Allowance***

7. The following is an examiner's statement of reasons for allowance:

Independent claim 17 describes the construction of a low impedance conductor for a low impedance extension. The conductor comprises a conductive outer surface and inner core having different impedances, but whose composite resistance ranges from 0.05-0.3 ohms per centimeter. Although the prior art references of record, recently submitted by the applicant, admit of conductors constructed with conductive inner cores and outer surfaces, these references primarily tout the use of platinum, silver, or copper inner cores surrounded by outer surfaces of either MP35N or titanium. According to the electrical resistivity property data supplied by MatWeb (see accompanying PTO-892), a composite sum of resistance between any two of these materials would still be orders of magnitude smaller than applicant's claimed range of 0.05-0.3 ohms per centimeter. The Examiner was unable to find a conductor having this arrangement with the resistance ranges claimed; consequently, the Examiner deems independent claim 17 and depending claims 18-20 to be allowable over the prior art of record.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Application/Control Number: 10/686,108  
Art Unit: 3762

---

Page 4

CHL  
5/7/2005



## Platinum, Pt, CP Grade, Hard Drawn - 50% Cold Worked

[Return to last](#)

[Printer friendly version](#)

[Add to bag](#)

[Download to Excel \(requires Excel and Windows\)](#)

[Material sup](#)

**Subcategory:** Metal; Nonferrous Metal; Precious Metal; Pure Metallic Element

### Component Wt. %

Pt 99.95

### Material Notes:

CP Grade (Commercially Pure) is 99.95% pure. Hard Drawn - 50% Cold Worked applies to strength, modulus, and hardness; other values are typical of Pt.

[Click here to view available vendors for this material.](#)

| Physical Properties          | Metric        | English                  | Comments         |
|------------------------------|---------------|--------------------------|------------------|
| Density                      | 21.45 g/cc    | 0.775 lb/in <sup>3</sup> |                  |
| <b>Mechanical Properties</b> |               |                          |                  |
| Hardness, Knoop              | 103           | 103                      | Estimated from V |
| Hardness, Rockwell B         | 49            | 49                       | Estimated from V |
| Hardness, Vickers            | 90            | 90                       |                  |
| Tensile Strength, Ultimate   | 205 - 240 MPa | 29700 - 34800 psi        |                  |
| Elongation at Break          | 1 - 3 %       | 1 - 3 %                  | in               |
| Modulus of Elasticity        | 156 GPa       | 22600 ksi                | static in t      |
| Poisson's Ratio              | 0.39          | 0.39                     |                  |
| Shear Modulus                | 56 GPa        | 8120 ksi                 | Calculated       |

### Electrical Properties

|                         |                  |                  |                                        |
|-------------------------|------------------|------------------|----------------------------------------|
| Electrical Resistivity  | 1.06e-005 ohm-cm | 1.06e-005 ohm-cm | Temperature Coefficient of resistivity |
| Magnetic Susceptibility | 1.1e-006         | 1.1e-006         | 0.0                                    |

**Thermal Properties**

|                      |                                                                 |                                                  |
|----------------------|-----------------------------------------------------------------|--------------------------------------------------|
| Heat of Fusion       | <u>113 J/g</u>                                                  | 48.6 BTU/lb                                      |
| CTE, linear 20°C     | <u>9.1 <math>\mu\text{m}/\text{m}\cdot^\circ\text{C}</math></u> | 5.06 $\mu\text{in}/\text{in}\cdot^\circ\text{F}$ |
| Heat Capacity        | <u>0.134 J/g<math>\cdot^\circ\text{C}</math></u>                | 0.032 BTU/lb $\cdot^\circ\text{F}$               |
| Thermal Conductivity | <u>69.1 W/m-K</u>                                               | 480 BTU-in/hr-ft $\cdot^\circ\text{F}$           |
| Melting Point        | <u>1769 <math>^\circ\text{C}</math></u>                         | 3220 $^\circ\text{F}$                            |

**Optical Properties**

|                                       |       |       |                            |
|---------------------------------------|-------|-------|----------------------------|
| Emissivity (0-1)                      | 0.152 | 0.152 | at 1000°C for total hemisp |
| Emissivity (0-1)                      | 0.3   | 0.3   | €                          |
| Reflection Coefficient, Visible (0-1) | 0.7   | 0.7   | bulk Pt; 5                 |

 [Printer friendly](#)
References for this datasheet.

Some of the values displayed above may have been converted from their original units and/or rounded in order to display the information in a consistent manner. Users requiring more precise data for scientific or engineering calculations can click on the property value to see the original value as well as raw conversion to equivalent units. We advise that you only use the original value or one of its raw conversions in your calculations to minimize rounding error. We also ask that you refer to MatWeb's disclaimer and terms of use regarding this information. [Click here](#) to view all the property values for this datasheet as they were entered into MatWeb.



## Subscribe to Premium Services

**Searches:** Advanced • Composition • Property • Material Type • Manufacturer • Trade Name • UNS Number

**Other Links:** Advertising • Submit Data • Database Licensing • Web Design & Hosting • Trade Publications

Supplier List • Unit Converter • Reference • News • Links • Help • Contact Us • Site Map • FAQ • Home

Please read our License Agreement regarding materials data and our Privacy Policy. Questions or comments about MatWeb? Please contact [webmaster@matweb.com](mailto:webmaster@matweb.com). We appreciate your input.

Site designed and maintained by Automation Creations, Inc. The contents of this web site, the MatWeb logo, and "MatWeb" are Copyright 1996 by Automation Creations, Inc. MatWeb is intended for personal, non-commercial use. The contents, results, and technical data from this site may not be reproduced either electronically, photographically or substantively without permission from Automation Creations, Inc.



Click Here to Learn About Buehler's New  
**PowerPac® 3 System**  
 The Complete System

Scientific equipment and supplies for use in materials analysis.

## Copper, Cu; Cold Drawn

[Return to last :](#)

[Printer friendly version](#)

[Download to Excel \(requires Excel and Windows\)](#)

[Add to bag](#)

[Material sup...](#)

**Subcategory:** Copper Alloy; Metal; Nonferrous Metal; Pure Metallic Element

**Close Analogs:** See entry for annealed and cold worked copper.

### Component Wt. %

Cu 100

### Material Notes:

Cold drawn applies only to tensile and/or hardness values; other property values are typical of the element. This entry is for pure Cu. Alloys will be included in the future.

[Click here to view available vendors for this material.](#)

| Physical Properties | Metric    | English                  | Comments |
|---------------------|-----------|--------------------------|----------|
| Density             | 8.96 g/cc | 0.324 lb/in <sup>3</sup> |          |

0.324 lb/in<sup>3</sup>

### Mechanical Properties

| Mechanical Properties      | Metric    | English   | Comments |
|----------------------------|-----------|-----------|----------|
| Hardness, Rockwell B       | 37        | 37        |          |
| Tensile Strength, Ultimate | 344 MPa   | 49900 psi |          |
| Tensile Strength, Yield    | 333.4 MPa | 48400 psi |          |
| Elongation at Break        | 14 %      | 14 %      |          |
| Modulus of Elasticity      | 110 GPa   | 16000 ksi |          |
| Bulk Modulus               | 140 GPa   | 20300 ksi |          |
| Poisson's Ratio            | 0.364     | 0.364     |          |
| Shear Modulus              | 46 GPa    | 6670 ksi  |          |

### Electrical Properties

|                         |                 |                 |
|-------------------------|-----------------|-----------------|
| Electrical Resistivity  | 1.7e-006 ohm-cm | 1.7e-006 ohm-cm |
| Magnetic Susceptibility | -8e-008         | -8e-008         |

### Thermal Properties

|                      |                                                |                                                  |                   |
|----------------------|------------------------------------------------|--------------------------------------------------|-------------------|
| Heat of Fusion       | 204.8 J/g                                      | 88.1 BTU/lb                                      |                   |
| CTE, linear 20°C     | 16.4 $\mu\text{m}/\text{m}\cdot^\circ\text{C}$ | 9.11 $\mu\text{in}/\text{in}\cdot^\circ\text{F}$ | over the range 20 |
| CTE, linear 250°C    | 18.5 $\mu\text{m}/\text{m}\cdot^\circ\text{C}$ | 10.3 $\mu\text{in}/\text{in}\cdot^\circ\text{F}$ |                   |
| CTE, linear 500°C    | 20.2 $\mu\text{m}/\text{m}\cdot^\circ\text{C}$ | 11.2 $\mu\text{in}/\text{in}\cdot^\circ\text{F}$ |                   |
| CTE, linear 1000°C   | 24.8 $\mu\text{m}/\text{m}\cdot^\circ\text{C}$ | 13.8 $\mu\text{in}/\text{in}\cdot^\circ\text{F}$ | at                |
| Heat Capacity        | 0.385 J/g-°C                                   | 0.092 BTU/lb-°F                                  |                   |
| Thermal Conductivity | 385 W/m-K                                      | 2670 BTU-in/hr-ft <sup>2</sup> -°F               |                   |
| Melting Point        | 1083.2 - 1083.6 °C                             | 1980 - 1980 °F                                   |                   |

### Optical Properties

|                                       |      |      |                  |
|---------------------------------------|------|------|------------------|
| Emissivity (0-1)                      | 0.15 | 0.15 | 655 nm, 807°C, p |
| Reflection Coefficient, Visible (0-1) | 0.63 | 0.63 |                  |

 [Printer friendly](#)

### References for this datasheet.

Some of the values displayed above may have been converted from their original units and/or rounded in order to display the information in a consistent manner. Users requiring more precise data for scientific or engineering calculations can click on the property value to see the original value as well as raw conversion to equivalent units. We advise that you only use the original value or one of its raw conversions in your calculations to minimize rounding error. We also ask that you refer to MatWeb's disclaimer and terms of use regarding this information. [Click here](#) to view all the property values for this datasheet as they were entered into MatWeb.



[Scientific equipment and supplies for use in materials analysis.](#)

#### Subscribe to Premium Services

**Searches:** Advanced • Composition • Property • Material Type • Manufacturer • Trade Name • UNS Number

**Other Links:** Advertising • Submit Data • Database Licensing • Web Design & Hosting • Trade Publications

Supplier List • Unit Converter • Reference • News • Links • Help • Contact Us • Site Map • FAQ • Home

Please read our License Agreement regarding materials data and our Privacy Policy. Questions or comments about MatWeb? Please contact [webmaster@matweb.com](mailto:webmaster@matweb.com). We appreciate your input.

Site designed and maintained by Automation Creations, Inc. The contents of this web site, the MatWeb logo, and "MatWeb" are Copyright 1996 by Automation Creations, Inc. MatWeb is intended for personal, non-commercial use. The contents, results, and technical data from this site may not be reproduced either electronically, photographically or substantively without permission from Automation Creations, Inc.

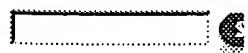


New! SolidWorks/COSMOSWorks library exports. 

Data sheets for over 47,000 metals, plastics, ceramics, and composites.

HOME • SEARCH • TOOLS • FORUM • BASKET • ABOUT US • FAQ

Searches: Advanced | Material Type | Property | Composition | Trade Name | Manufacturer



## Titanium, Ti

 Return to last

 [Printer friendly version](#)

[Add to bag](#)

 [Download to Excel \(requires Excel and Windows\)](#)

[Material sup](#)

**Subcategory:** Metal; Nonferrous Metal; Pure Metallic Element; Titanium Alloy

**Close Analogs:** A wide range of Ti alloys are listed in MatWeb. Titanium Grades 1,2,3,4,7,11, and 12 are all considered unalloyed. This listing is for 'pure' titanium.

**Key Words:** biomaterials, biomedical implants, biocompatibility

### Component Wt. %

Ti 100

### Material Notes:

This listing is for 'pure' titanium. Although unalloyed titanium is not very useful for structural applications, titanium is highly praised for their use in aerospace, high-temperature and biomedical applications. Titanium is difficult to machine or weld, but has significant advantages over traditional metals. For medical implants, titanium is considered one of the most biocompatible materials available, especially where direct contact to tissue or bone is required (i.e. endosteal dental implants or porous uncemented orthopedic implants). See the individual titanium alloy datasheets for specific applications.

[Click here to view available vendors for this material.](#)

| Physical Properties | Metric   | English                  | Com |
|---------------------|----------|--------------------------|-----|
| Density             | 4.5 g/cc | 0.163 lb/in <sup>3</sup> |     |

### Mechanical Properties

|                            |         |           |         |
|----------------------------|---------|-----------|---------|
| Hardness, Brinell          | 70      | 70        | electro |
| Hardness, Vickers          | 60      | 60        |         |
| Tensile Strength, Ultimate | 220 MPa | 31900 psi |         |
| Tensile Strength, Yield    | 140 MPa | 20300 psi |         |
| Elongation at Break        | 54 %    | 54 %      |         |
| Modulus of Elasticity      | 116 GPa | 16800 ksi |         |

|                 |      |      |
|-----------------|------|------|
| Poisson's Ratio | 0.34 | 0.34 |
|-----------------|------|------|

### Electrical Properties

|                                           |                         |                  |
|-------------------------------------------|-------------------------|------------------|
| Electrical Resistivity                    | <u>5.54e-005 ohm-cm</u> | 5.54e-005 ohm-cm |
| Magnetic Susceptibility                   | 1.25e-006               | 1.25e-006        |
| Critical Magnetic Field Strength, Oersted | 56                      | 56               |
| Critical Superconducting Temperature      | 0.36 - 0.44 K           | 0.36 - 0.44 K    |

### Thermal Properties

|                      |                                                                  |                                                     |                   |  |
|----------------------|------------------------------------------------------------------|-----------------------------------------------------|-------------------|--|
| Heat of Fusion       | <u>435.4 J/g</u>                                                 | 187 BTU/lb                                          |                   |  |
| CTE, linear 20°C     | <u>8.9 <math>\mu\text{m}/\text{m}\cdot^\circ\text{C}</math></u>  | 4.94 $\mu\text{in}/\text{in}\cdot^\circ\text{F}$    | over the range 20 |  |
| CTE, linear 1000°C   | <u>10.1 <math>\mu\text{m}/\text{m}\cdot^\circ\text{C}</math></u> | 5.61 $\mu\text{in}/\text{in}\cdot^\circ\text{F}$    |                   |  |
| Heat Capacity        | <u>0.528 J/g<math>^\circ\text{C}</math></u>                      | 0.126 BTU/lb $^\circ\text{F}$                       |                   |  |
| Thermal Conductivity | <u>17 W/m-K</u>                                                  | 118 BTU-in/hr $\cdot\text{ft}^2\cdot^\circ\text{F}$ |                   |  |
| Melting Point        | 1650 - 1670 °C                                                   | 3000 - 3040 °F                                      |                   |  |

### Optical Properties

|                  |      |      |               |
|------------------|------|------|---------------|
| Emissivity (0-1) | 0.63 | 0.63 | unoxidized; € |
|------------------|------|------|---------------|

 [Printer friendly](#)

### References for this datasheet.

Some of the values displayed above may have been converted from their original units and/or rounded in order to display the information in a consistent manner. Users requiring more precise data for scientific or engineering calculations can click on the property value to see the original value as well as raw conversion to equivalent units. We advise that you only use the original value or one of its raw conversions in your calculations to minimize rounding error. We also ask that you refer to MatWeb's disclaimer and terms of use regarding this information. [Click here](#) to view all the property values for this datasheet as they were entered into MatWeb.



[Subscribe to Premium Services](#)

**Searches:** Advanced • Composition • Property • Material Type • Manufacturer • Trade Name • UNS Number

**Other Links:** Advertising • Submit Data • Database Licensing • Web Design & Hosting • Trade Publications

Supplier List • Unit Converter • Reference • News • Links • Help • Contact Us • Site Map • FAQ • Home

Please read our License Agreement regarding materials data and our Privacy Policy. Questions or comments about MatWeb? Please contact [webmaster@matweb.com](mailto:webmaster@matweb.com). We appreciate your input.

Site designed and maintained by Automation Creations, Inc. The contents of this web site, the MatWeb logo, and "MatWeb" are Copyright 1996 by Automation Creations, Inc. MatWeb is intended for personal, non-commercial use. The contents, results, and technical data from this site may not be reproduced either electronically, photographically or substantively without permission from Automation Creations, Inc.



New! SolidWorks/COSMOSWorks library exports. 

Data sheets for over 47,000 metals, plastics, ceramics, and composites.

[HOME](#) • [SEARCH](#) • [TOOLS](#) • [FORUM](#) • [BASKET](#) • [ABOUT US](#) • [FAQ](#)

Searches: Advanced | Material Type | Property | Composition | Trade Name | Manufacturer



## Aluminum, Al

 [Return to last](#)

 [Printer friendly version](#)

[Add to bag](#)

 [Download to Excel \(requires Excel and Windows\)](#)

[Material sup](#)

**Subcategory:** Aluminum Alloy; Metal; Nonferrous Metal; Pure Metallic Element

**Close Analogs:** Over 425 Al alloys are listed in MatWeb. Aluminum 1199 is the highest purity (99.99% Al min.) commercially available in structural form.

### Component Wt. %

Al 100

### Material Notes:

This listing is for 'pure' aluminum.

[Click here](#) to view available vendors for this material.

| Physical Properties | Metric             | English                         | Comments |
|---------------------|--------------------|---------------------------------|----------|
| Density             | <u>2.6989 g/cc</u> | <u>0.0975 lb/in<sup>3</sup></u> |          |

### Mechanical Properties

|                       |               |                 |    |
|-----------------------|---------------|-----------------|----|
| Hardness, Vickers     | <u>15</u>     | <u>15</u>       | An |
| Modulus of Elasticity | <u>68 GPa</u> | <u>9860 ksi</u> |    |
| Shear Modulus         | <u>25 GPa</u> | <u>3630 ksi</u> |    |

### Electrical Properties

|                                           |                        |                        |
|-------------------------------------------|------------------------|------------------------|
| Electrical Resistivity                    | <u>2.7e-006 ohm-cm</u> | <u>2.7e-006 ohm-cm</u> |
| Magnetic Susceptibility                   | <u>6e-007</u>          | <u>6e-007</u>          |
| Critical Magnetic Field Strength, Oersted | <u>101.9 - 107.9</u>   | <u>101.9 - 107.9</u>   |
| Critical Superconducting Temperature      | <u>1.73 - 1.77 K</u>   | <u>1.73 - 1.77 K</u>   |

### Thermal Properties

|                      |                                                                  |                                                   |                    |
|----------------------|------------------------------------------------------------------|---------------------------------------------------|--------------------|
| Heat of Fusion       | <u>386.9 J/g</u>                                                 | 166 BTU/lb                                        |                    |
| CTE, linear 20°C     | <u>24 <math>\mu\text{m}/\text{m}\cdot^\circ\text{C}</math></u>   | 13.3 $\mu\text{in}/\text{in}\cdot^\circ\text{F}$  | over the range 20- |
| CTE, linear 250°C    | <u>25.5 <math>\mu\text{m}/\text{m}\cdot^\circ\text{C}</math></u> | 14.2 $\mu\text{in}/\text{in}\cdot^\circ\text{F}$  | over the range 20- |
| CTE, linear 500°C    | <u>27.4 <math>\mu\text{m}/\text{m}\cdot^\circ\text{C}</math></u> | 15.2 $\mu\text{in}/\text{in}\cdot^\circ\text{F}$  | over the range 20- |
| Heat Capacity        | <u>0.9 J/g-<math>^\circ\text{C}</math></u>                       | 0.215 BTU/lb- $^\circ\text{F}$                    |                    |
| Thermal Conductivity | <u>210 W/m-K</u>                                                 | 1460 BTU-in/hr-ft <sup>2</sup> - $^\circ\text{F}$ |                    |
| Melting Point        | <u>660.37 °C</u>                                                 | 1220 °F                                           |                    |

### Optical Properties

|                                       |           |           |              |
|---------------------------------------|-----------|-----------|--------------|
| Emissivity (0-1)                      | 0.2 - 0.3 | 0.2 - 0.3 | strongly o-  |
| Emissivity (0-1)                      | 0.05      | 0.05      | polished 50- |
| Reflection Coefficient, Visible (0-1) | 0.9       | 0.9       | tungste      |

 [Printer friendly](#)

### References for this datasheet.

Some of the values displayed above may have been converted from their original units and/or rounded in order to display the information in a consistent manner. Users requiring more precise data for scientific or engineering calculations can click on the property value to see the original value as well as raw conversion to equivalent units. We advise that you only use the original value or one of its raw conversions in your calculations to minimize rounding error. We also ask that you refer to MatWeb's disclaimer and terms of use regarding this information. [Click here](#) to view all the property values for this datasheet as they were entered into MatWeb.



#### Subscribe to Premium Services

**Searches:** Advanced • Composition • Property • Material Type • Manufacturer • Trade Name • UNS Number

**Other Links:** Advertising • Submit Data • Database Licensing • Web Design & Hosting • Trade Publications

Supplier List • Unit Converter • Reference • News • Links • Help • Contact Us • Site Map • FAQ • Home

Please read our License Agreement regarding materials data and our Privacy Policy. Questions or comments about MatWeb? Please contact [webmaster@matweb.com](mailto:webmaster@matweb.com). We appreciate your input.

Site designed and maintained by Automation Creations, Inc. The contents of this web site, the MatWeb logo, and "MatWeb" are Copyright 1996 by Automation Creations, Inc. MatWeb is intended for personal, non-commercial use. The contents, results, and technical data from this site may not be reproduced either electronically, photographically or substantively without permission from Automation Creations, Inc.